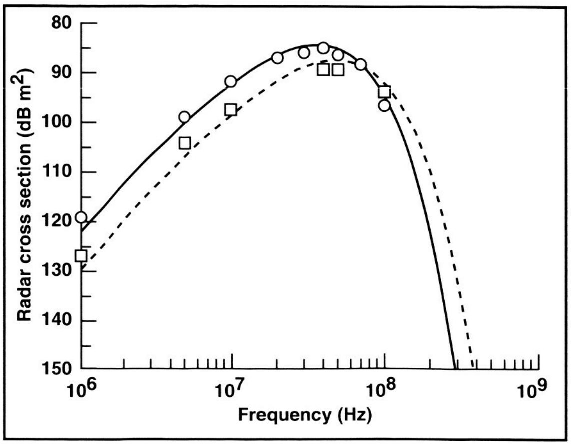

Fig. 1. Predicted radar cross-section (RCS) of aircraft vortices. The symbols show the results of a scattering analysis implemented computationally. The curves show the results of a simple but approximate analytical formula. Solid line and circle symbol: Vortex RCS for B-747 class aircraft. Dotted line and square symbol: Vortex RCS for DC-8 class aircraft. This figure is for a range of 1 km. Note that since aircraft vortices are not a point target, the RCS is a function of range and so the plotted results should not be used for other ranges.

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Uncertainties in Prediction of Wake-Vortex Locations

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The capacity of many of the nation's airports is now limited by procedures that require sufficient separation distances between arrival and departures to prevent a trailing aircraft from encountering the vortex wake of a preceding aircraft. Vortex wakes must be avoided because, during the first few minutes of their duration, they contain intense swirling motions that can cause encountering aircraft to roll uncontrollably, and possibly crash. Considerable research is under way to better predict the location of vortices (shed by the leading aircraft) so that the trailing aircraft can avoid the hazardous region without excessive spacing. The objective of the work at Ames is to determine the principal sources of uncertainty associated with predicting the trailing aircraft's position relative to the vortex wakes being shed by the leading aircraft, and the effect that these uncertainties have on the spacing requirements between the two aircraft.

The primary factors that need to be considered in any computation directed at determining a vortex position relative to a trailing aircraft are (1) the location of the wake-generating aircraft's flightpath, because it establishes the beginning location of the vortex wake; (2) the self-induced descent velocity of the vortex pair; (3) the size and location of the wake-hazardous region; (4) the wind velocity along the flightpath of each aircraft, and its variation with time; and (5) the location of the following aircraft's flightpath. The flightpath of the trailing aircraft must be included, because it is an important factor in determining the probability of an encounter. With the exception of the self-induced descent velocity of the vortex pair, all of these factors contain enough uncertainty to significantly affect the probability of a hazardous encounter for a given set of procedures and spacings for aircraft on arrival or departure at an airport.

Numerical simulation of a wide variety of arrival operations was used to study the effect of these uncertainties on the probability of a wake encounter by a following aircraft. In the study, the size of the hazardous region and the level of uncertainties in the winds along the flightpath were varied to determine their effect on encounter probability. The uncertainty in the position of the leading and trailing aircraft was also varied in the study to cover the various levels of location accuracy achievable with the conventional instrument landing system, and with the significant improvement in the location accuracy achievable with the Local Area Augmentation System (LAAS). The LAAS is a landing-guidance system that is based on the Global Positioning Satellite System (GPSS). These simulation studies demonstrated that by implementing a more accurate aircraft positioning system based on GPSS and improving the wind measurements along the flightpath of the wake-generating aircraft, a significant reduction could be realized in the probability of a wake-vortex encounter by a trailing aircraft. That is, for the same procedures currently in use, the foregoing improvements would translate into a potential reduction in spacing, while maintaining safety margins that are the same or greater than those in current use. The study also suggests that the proposed reduction in uncertainties may provide an ability to develop radically new and much more effective wake-vortex avoidance procedures that would not be possible with the current system at airports. For example, it may be possible to safely arrange a sequence of multiple flight corridors to airports that have a large landing surface area, instead of separate runways that accommodate only single flight corridors.

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Remote Tower Sensor System

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The Remote Tower Sensor System (RTSS) is a proof-of-concept prototype being developed by Ames Research Center in collaboration with the Federal Aviation Administration (FAA) and the National Oceanic and Atmospheric Administration (NOAA). Once fully installed, the system will greatly help San Francisco International Airport (SFO) improve predictions of landing conditions during weather transition periods by providing a better understanding of the formation and dissipation of clouds, weather, and wind currents in and around the airport approach zone. The project utilizes live video that is accessible over a secure Internet site. The camera system employs advanced image processing technologies to help controllers and forecasters understand and predict critical weather situations. RTSS is leveraging off the existing Airport Approach Zone Camera System (AAZCS) project of real-time weather observations at SFO.

In FY00 the RTSS team set up a portable remote tower sensor test bed on the roof of building 269 at Ames (see fig. 1). Once testing is completed, this portable remote tower will be deployed at Half Moon Bay Airport as the first "virtual tower system" that will integrate real-time airport data in support of operations at airports without towers. Some of the key components consist of an ultrasonic wind sensor, air-temperature and relative humidity sensor, barometric pressure sensor, solar panels, wireless Ethernet, PTZ (Pan-Tilt-Zoom) motion camera, web access and logging.